

METHODS AND MODELS OF MARINE OPTICS SOURCES AND SINKS

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LONG-TERM GOALS

The long-term goal of the principal investigator is to improve our understanding of marine photosynthesis and optical variability in the oceans. Specifically, an understanding of the mechanisms causing regional differentiation in bio-optical relationships and photosynthetic models is desired. This requires methods for measurement of various optical components and the rates of production and loss of its components. The research emphasis is to understand the bulk inherent and apparent optical properties through study of constituent components to develop detailed parameterization for optical models by indirect optical techniques that predict biomass and photosynthetic adaptation. Laboratory experiments and field observations in diverse ecosystems will lead to an understanding of the diversity of bio-optical relationships and a fundamental understanding of that variability.

OBJECTIVES

Six separate objectives were pursued in FY-97. These included (i) laboratory studies of polar phytoplankton photophysiology; (ii) study of xanthophyll cycling in *Phaeocystis antarctica*; (iii) development and refinement of methods to estimate absorption by dissolved organic material in seawater; (iv) integration of an *in situ* inherent optical property profiling system (AC-9) to the CalCOFI bio-optics program; (v) development of model parameterizations and integration of observation and modeling approaches; and (vi) implementation of a spectral microphotometer to study optical properties of individual ocean phytoplankton.

APPROACH

For objective (i) *Phaeocystis* sp. was grown under light-limited semi-continuous culture. Studies of photophysiological parameters were made at steady state. For objective (ii) we tested whether *Phaeocystis* cultures demonstrated xanthophyll cycling between diatoxanthin and diadinoxanthin at short time scales. Objective (iii) included development of improved methods for estimation of

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soluble absorption (a_s) during CalCOFI cruises. We participated in eight CalCOFI cruises during which we carried out studies of inherent and apparent optical properties in Southern California coastal waters and adjacent waters of the California current. As an enhancement of our existing bio-optical profiling system, we integrated two AC-9 instruments (objective iv) and we used our data set to develop parameterizations for absorption coefficients and evaluated our parameterizations using Hydrolight and our observational data (objective v). For objective (vi) we initiated studies with a spectral microphotometer on the use of absorption cross-sections for objective identification of kelp zoospores (Graham and Mitchell 1998) and for individual phytoplankton (Hewes et al. 1998).

WORK COMPLETED

Two manuscripts on the photophysiology of *Phaeocystis* sp. were submitted. The work included use of a fluorescence excitation of chlorophyll-a as a proxy for phytoplankton photosynthetic absorption (Sosik and Mitchell 1995) and studies of xanthophyll cycling in response to rapid light changes (objective ii). A large data set of absorption and fluorescence of soluble matter (cDOM) was collected (objective iii). For objective iv, we completed 8 CalCOFI cruises, collecting a large data set of IOP and AOP *in situ* (AC-9, MER 2040) supported by HPLC pigments and estimates of particulate and soluble absorption (a_p , a_s) for water samples. These data were used to develop advanced parameterizations for bio-optical models which were compared to previous parameterizations (Morel 1988, 1991) and evaluated the implications for optical modeling using Hydrolight (objective v). The bio-optical parameterizations in Hydrolight were published in Mitchell et al. 1996. A study of the phycobiliprotein absorption and fluorescence within the dinoflagellate *Dinophysis* sp. was completed using the spectral microphotometer.

RESULTS

Our work on the photophysiology of phytoplankton continues to guide our concepts of photosynthetic modeling and model parameterization. ONR support has led to results on the fundamental optical physiology of phytoplankton, which has shown that the chl a-specific absorption coefficient and the quantum yield of photosynthesis are dependent not only on the light environment but also on the nutrient and temperature environment (Mitchell and Kiefer 1988; Sosik and Mitchell 1991; Sosik and Mitchell 1994). In FY-97 we completed studies on steady state light limitation as well as short-term light transition for the polar blooming prymnesiophyte *Phaeocystis* sp. (Moisan and Mitchell 1998). We found significant differences in the Morel (1988, 1991) parameterization for total absorption in the Hydrolight model (Mobley 1994) and in our estimates from direct laboratory measurements (Mitchell et al. 1996). The study of *Dinophysis* phycoerythrin raises interesting questions about the evolution of the genus (Hewes et al. 1998). Results have been published or are submitted for each of the objectives of the project.

IMPACT

Our approach is to make both bulk optical measurements as well as detailed measurements of the constituent components both in the laboratory and field studies. Through this compartmentalization approach, we are able to develop improved optical parameterizations for both phytoplankton growth and ocean optical models. Our methods, ranging from detailed spectral microphotometry to laboratory methods for particle and soluble absorption estimates to processing schemes for AC9 and spectral reflection profilers, have been used by numerous other ONR sponsored scientists.

TRANSITIONS

None

RELATED PROJECTS

For CalCOFI cruises, we continue to collaborate with ONR PIs Ralf Goericke on his project to determine HPLC pigments from numerous cruises, and Loren Haury on studies of nutrient transients during CalCOFI 9610. Dariusz Stramski and Piotr Flatau are co investigators on our Japan/East Sea DRI funding which was recently awarded.

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